



CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

9231/42

October/November 2023

1 hour 30 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [].

This document has **16** pages. Any blank pages are indicated.

BLANK PAGE

- 1 A factory produces small bottles of natural spring water. Two different machines, X and Y , are used to fill empty bottles with the water. A quality control engineer checks the volumes of water in the bottles filled by each of the machines. He chooses a random sample of 60 bottles filled by machine X and a random sample of 75 bottles filled by machine Y . The volumes of water, x and y respectively, in millilitres, are summarised as follows.

$$\Sigma x = 6345 \quad \Sigma (x - \bar{x})^2 = 243.8 \quad \Sigma y = 7614 \quad \Sigma (y - \bar{y})^2 = 384.9$$

$\bar{x}$ and $\bar{y}$ are the sample means of the volume of water in the bottles filled by machines X and Y respectively.

Find a 95% confidence interval for the difference between the mean volume of water in bottles filled by machine X and the mean volume of water in bottles filled by machine Y . [6]

[illegible]

- 2 The number of breakdowns on a particular section of road is recorded each day over a period of 90 days. It is suggested that the number of breakdowns follows a Poisson distribution with mean 3.5. The data is summarised in the table, together with some of the expected frequencies resulting from the suggested Poisson distribution.

Number of breakdowns per day	0	1	2	3	4	5	6	7	8 or more
Observed frequency	0	5	13	17	21	16	9	5	4
Expected frequency	2.718	9.512	16.646		16.993	11.895		3.469	2.407

- (a) Complete the table. [2]

This image shows a single sheet of white paper with ten horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- (b)** Carry out a goodness of fit test, at the 10% significance level, to determine whether or not $Po(3.5)$ is a good fit to the data. [6]

[illegible]

- 3 Toby has a bag which contains 6 red marbles and 3 green marbles. He randomly chooses 3 marbles from the bag, without replacement. The random variable X is the number of red marbles that Toby obtains.

(a) Find the probability generating function of X . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Ling also has a bag which contains 6 red marbles and 3 green marbles. He randomly chooses 2 marbles from his bag, without replacement. The random variable Y is the number of red marbles that Ling obtains. It is given that the probability generating function of Y is $\frac{1}{12}(1 + 6t + 5t^2)$.

The random variable Z is the total number of red marbles that Toby and Ling obtain.

(b) Find the probability generating function of Z , expressing your answer as a polynomial in t . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c) Use the probability generating function of Z to find $\text{Var}(Z)$. [4]



where a , b and c are constants.

The upper quartile of X is equal to 4.

-
- This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(b) Find the exact value of the median of X .

[3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Find $E(\sqrt{X})$, giving your answer correct to 2 decimal places.

[3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 5 A company is deciding which of two machines, X and Y , can make a certain type of electrical component more quickly. The times taken, in minutes, to make one component of this type are recorded for a random sample of 8 components made by machine X and a random sample of 9 components made by machine Y . These times are as follows.

Machine X	4.0	4.6	4.7	4.8	5.0	5.2	5.6	5.8	
Machine Y	4.5	4.9	5.1	5.3	5.4	5.7	5.9	6.3	6.4

The manager claims that on average the time taken by machine X to make one component is less than that taken by machine Y .

- (a) Carry out a Wilcoxon rank-sum test at the 5% significance level to test whether the manager's claim is supported by the data. [6]

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- (b)** Assuming that the times taken to produce the components by the two machines are normally distributed with equal variances, carry out a t -test at the 5% significance level to test whether the manager's claim is supported by the data. [9]

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dashed lines, providing a guide for letter height and placement. The lines are evenly spaced across the entire page, leaving ample room for writing practice. There is no text or other markings on the page.

Question 5(c) is printed on the next page.

- (c) In general, would you expect the conclusions from the tests in parts (a) and (b) to be the same? Give a reason for your answer. [1]

Additional page

If you use the following page to complete the answer to any question, the question number must be clearly shown.

[illegible]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.